0054920

INSTRUCTION GUIDE

FOR

REMEDIATION OF THE 100 AREAS WASTE SITES

BHI-DIS DE7 1/22/99

02	1/99	Update document and incorporate changes consistent with standard practices and revised SAP.	JDH	KEC	SAP	FMC
01	10/96	Revised per DCN-0100X-IG-G0001-00-01 and incorporation of Group 2 waste site information	KLD	MCT	MCT	ALL
REV.	DATE	REASON FOR REVISION	ORIGINATOR	CHECKER	GROUP SUPVR	PROJ. ENGR/ DES

RICHLAND ENVIRONMENTAL RESTORATION PROJECT	JOB NO. 22192
	*INSTRUCTION GUIDE NO. 0100X-IG-G0001
	SHEET 1 of 44

APPROVAL PAGE

Document Title: INSTRUCTION GUIDE FOR THE REMEDIATION OF THE 100 AREAS WASTE SITES

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CONTENTS

CONTENTS (continued)

APPENDICES

1.0 PURPOSE

This instruction guide (IG) provides direction to field analytical personnel for implementing the *100 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 1998a). The SAP is the controlling document for performing work. All references to the SAP appear as underlined and italics to distinguish SAP references from IG references. This IG will be revised as field conditions dictate or when upper-tier requirements in the SAP are changed. The IG is issued and controlled as an instruction guide. All revisions to the IG will be approved by the Resident Engineer using a Design Change Notice (DCN). The Resident Engineer for each of the remediation projects covered by the SAP will provide direction as needed and as described in this IG.

1.1 RESPONSIBILITIES

Resident Engineer is responsible to plan and direct excavation guidance sampling/field screening events so these events are conducted prior to excavation with minimum interference to the excavation process.

Analytic Lead reviews field measurements and laboratory results and informs the Resident Engineer of trends and anomalies. A Sample Authorization Form (SAF) will be prepared for each remedial action activity that provides analytical parameters, analytical methods, sample container type and volume, and holding time for each laboratory (e.g., standard fixed laboratory [SFL] or quick turnaround laboratory [QTL]). The Analytical Lead is responsible for informing the Radiological Supervisor of the locations where radiological control technical (RCT) screening is required.

Samplers/Field Screeners are responsible for maintaining the training and qualifications and for conducting work in accordance with BHI-QA-03, *ERC Quality Assurance Program Plans*, Plan 5.1, "Field Sampling Quality Assurance Program Plan" and Plan 5.2, "Onsite Measurements Quality Assurance Program Plan," as well as the SAP and this IG. Samplers/Field Screeners will report results to the Analytical Lead daily and will immediately notify the Resident Engineer if action levels or trip points have been reached.

Radiological Controls Supervisor is responsible for ensuring the Radiological Control Technicians (RCTs) maintain the desired level of training and qualifications for conducting work in accordance with BHI-QA-03, Plan 5.3, "Radiological Measurements and Environmental Support Quality Assurance Program Plan," as well as the SAP and this IG. The RCTs will report results to the Radiological Supervisor and Analytic Lead daily. The Radiological Supervisor will immediately notify the Resident Engineer and Analytic Lead if action levels or trip points have been reached.

1.2 DEFINITIONS

Decision Unit: A geographically defined portion of a waste site (excavation footprint and layback) or overburden material enclosing in one or more subunits. Generally, a waste site will be divided into the following decision units: (1) stockpiled "clean" soil (overburden/layback) that will be returned to the excavation, (2) soil from the bottom of the excavation when excavation is from 0 to 4.6 m (0 to 15 ft) below ground surface, and (3) soil from the bottom of the excavation when excavation is greater than 4.6 m (15 ft) below ground surface. Additional units may be defined as needed for large sites or other specific needs. Verification sampling and analysis data will be evaluated against the decision rules on a unit-by-unit basis. Small sites may have only one decision unit that is used for both shallow zone and deep zone verification purposes.

Deep Zone: The portion of material from below 4.6 m (15 ft) deep (relative to grade level) and is subject to verification of compliance with direct exposure (ingestion-related), groundwater and Columbia River cleanup criteria of the remedial design report/remedial action work plan (RDR/RAWP) (DOE-RL 1998b). The deep zone is typically represented by the secondary decision unit and consisting of subunits with three sample areas.

Overburden/Layback: The portion of material from the surface to just above contaminated soil, and soil to the sides of contaminated soils. Overburden/layback soil is the soil that appears to be "clean" based on field instruments but must be verified to meet shallow zone cleanup criteria. Verification is performed by the same process as that used for shallow zone soils.

Required Number of Samples Computation: Using variance sample analytical results, a calculation is performed of the required number of samples for site verification. Guidelines are provided in Appendix C of this IG. Six discrete variance samples are collected from random nodes within each sample grid (six variance samples per sample area). The variance samples are used to indicate contaminant variability within a decision unit.

Sample Area: A geographically defined portion of the shallow zone of a waste site (e.g., excavation footprint and layback) or overburden material that is typically made up of one-quarter of a subunit. A geographically defined portion of the deep zone of a waste site (e.g., excavation footprint and layback) that is typically made up of one-third of a subunit. The actual number of sampling areas is dependent on the outcome of the required number of sample computations performed to assess contaminant variability. Each sample area, whether shallow or deep zone, is divided into 16 equal area sample nodes and is represented by one verification sample. Sample areas encompass equal areas within a subunit.

Sample Node: One-sixteenth of a sample area. Sample nodes encompass equal areas within a sample area. Discrete samples taken from six nodes are analyzed and used for variance calculations. Discrete samples taken from four nodes are composited, analyzed, and used for site verification.

Shallow Zone: The portion of material and excavation surfaces from grade level to 4.6 m (15 ft) below grade level. This area is subject to verification of compliance with direct exposure cleanup criteria of the RDR/RAWP (DOE-RL 1998b). Represented by the primary decision unit and consisting of subunits with four sample areas.

Subunit: A geographically defined portion of a decision unit, as required by Table 5-1. A single subunit may be of equal size and area as the decision unit (small sites) but shall not exceed the size and boundary of the decision unit. For larger sites, multiple subunits may be enclosed by a single decision unit.

Variance Samples: Also known as variability samples, variance samples are used to assess contaminant variability and statistical distribution. Variance sampling is only required for overburden and shallow zone decision unit variability assessment. Six variance samples per sample subunit are collected and sent to the radiological counting facility (RCF) for analysis of contaminants of concern (COCs), typically by gamma-energy analysis with a high-purity germanium (HPGe) detector. Variance sample results are used to estimate the site dose (based on comparison to lookup values published in the RDR/RAWP [DOE-RL 1998b]) and calculate the required number of sample for site verification.

Verification Samples: Verification samples are used to determine site status relative to the cleanup criteria established in the RDR/RAWP. The default number of verification samples per shallow subunit is four, but additional samples may be required based on the required number of samples computation performed in accordance with Appendix A of the SAP (refer to Appendix C of this IG). The default number of verification samples per deep subunit is three.

2.0 WASTE SITES

The waste sites are discussed in the SAP, and the COCs are addressed under *Section I* of the SAP. Waste-site-specific COCs are listed in *Tables I-6a* through *I-6d* in the SAP. Miscellaneous site-specific information and additional COCs that are not discussed in the SAP are included as Appendix B of this IG. Waste sites and their respective COCs not specifically identified in this IG will be described in other supporting documents as deemed necessary by the Resident Engineer.

Table 2-1 (corresponding to SAP's *Table III-1*) provides the general sample locations, frequencies, and sampling methods. Sections 4.0 through 9.0 of this IG describe how to perform sampling in accordance with this table. Functional tables providing specific information for sampling and analysis are also presented in Sections 4.0 through 9.0 of this IG; these functional tables should be used for implementation.

Table 2-1. Sample Locations, Frequencies, Sampling Methods.[a] (2 Pages)

Decision Objectives	Decision Boundaries	Physical Samples #	
		Samples	Sampling Methods
1. Waste Profile: excavation and disposal	Per Section 4.0	As site warrants	Per Resident Engineer
2. Site Variability: (required number of verification samples)	Table 5-1	24 discrete samples; divide subunit into 4 sample areas; collect 6 samples per sample area	Discrete

Table 2-1. Sample Locations, Frequencies, Sampling Methods.[a] (2 Pages)

		Physical Samples #	
3. Site Verification: overburden/lay-back	Table 5-1	4 composite samples; divide overburden into 4 sample areas; collect 4 samples/area, and composite to 1 per sample area[b]	Composite
3a. Site Verification: waste site shallow zone	Table 5-1	4 composite samples; divide subunit into 4 sample areas, collect 4 samples per area, and composite to 1 per sample area[b]	Composite
3b. Site Verification: waste site deep zone	Table 5-1	3 composite samples; divide subunit into 3 sample areas, collect 4 samples per area, and composite to 1 sample per area[b]	Composite
4. Backfill	Entire borrow pit	No samples	Radiation survey

[a] Table 2-1 is based on the data quality objectives (DQO) process for the waste sites identified in the SAP. Additional waste sites and parameters/uses/levels will be identified after future DQO processes for remaining sites and will be described in other supporting documents.

[b] Default plan = number of total samples may be revised per outcome of variance sampling results and corresponding "required number of samples" computation.

Site drawings showing excavation site boundaries should be obtained from the Resident Engineer. Once obtained, the drawing number, revision, and date shall be noted in the field logbook and will be the basis for all screening and sampling. Subsequent changes in drawings shall be logged. Alternately, copies of the drawings may be taped into the field logbook.

3.0 SITE PREPARATION

Establish a sampling grid on the drawing over the waste site using Washington State Plane coordinates as a reference. The staking of the grid will be directed by the Resident Engineer.

If it is expected that the excavation surface will not be accessible after excavation is complete, refer to Section 7.0 of this IG for instructions on determining verification sample locations <u>before excavation begins</u>.

4.0 FIELD MEASUREMENTS DURING EXCAVATION

The typical frequency and location requirements for field measurements taken to guide each phase of excavation are discussed in the following subsections. However, if any of the following are observed during any phase of excavation, a systematic sampling approach shall be initiated to collect discrete samples:

- Health and safety action levels are approached (refer to site-specific health and safety plan and radiation work permit)
- Visual anomalies are encountered
- Contaminant concentrations approach Environmental Restoration Disposal Facility (ERDF) waste acceptance criteria (see Table 4-2)
- Increase in contamination levels encountered determined by Field Screening that warrant sample collection, as determined by the Resident Engineer
- Lack of data to support development of waste profile, as determined by Resident Engineer.

Notify the Resident Engineer immediately if one of the above situations occurs or the action/trip levels listed in Table 4-2 are reached. The Resident Engineer may request additional field measurements and/or discrete sampling for analysis of COCs at the QTL. The actual sampling frequency/interval for this sampling event will be determined based on actual field conditions.

The laboratory-specific procedures for the QTL and the SFL will be referenced in the SAFs generated for each remedial action project to ensure consistency of methods used.

Table 4-1 (derived from SAP *Tables III-2a* and *III-3*) provides the quality control sampling requirements for discrete sampling during excavation. Field split samples should be collected from the same sample as field duplicates.

Table 4-1. Field Quality Control Requirements for Discrete Sampling During Excavation.

QC Sample Type	Frequency	Laboratory
Field duplicates	5% of all samples or a minimum of 1 sample per sampling unit[b]	QTL
Field splits	5% of all samples or a minimum of 1 sample per sampling unit[b]	SFL
Blind samples	Determined by Resident Engineer	QTL

[a] Work sites as described in Section 1-1 of the SAP.
[b] Sampling unit is the decision unit, such as the overburden/layback, deep zone, or shallow zone.

Table 4-2. Action Levels Triggering a Sampling Effort.[a]

COC	Field Instrument	ERDF Waste Acceptance Criteria[b] (values below given in pCi/g)	ERDF Waste Acceptance Criteria Trip Levels[c]
^{241}Am	HPGe	30,000	2 x waste profile
$^{60}Co/^{152}Eu$	NaI	NL[d]	2 x waste profile
^{137}Cs	HPGe	19,000,000	2 x waste profile
^{152}Eu	HPGe	1.26e+13	2 x waste profile
^{154}Eu	HPGe	NL[d]	2 x waste profile
^{155}Eu	HPGe	NL[d]	2 x waste profile
^{238}Pu	N/A[e]	902,000	2 x waste profile
$^{239/240}Pu$	N/A[e]	17,400	2 x waste profile
^{90}Sr	Beta	8.42e+09	2 x waste profile
^{238}U	Alpha	7,220	2 x waste profile
COC	**Field Instrument**	**ERDF Waste Acceptance Criteria[b] (values below given in mg/kg)**	**ERDF Waste Acceptance Criteria Trip Levels[c]**
Cr (Total)	XRF	59,000	2 x waste profile
Cr (VI)	HACH test kit	59,000	2 x waste profile
Hg	XRF	1,000	2 x waste profile
Pb	XRF	5,000	2 x waste profile
PCB	Immunoassay	500	2 x waste profile

[a] When these trip levels are reached, systematic sampling can begin at the direction of the Resident Engineer. Additional information pertinent to selected COCs at specific sites is included in Appendix B.
[b] ERDF waste acceptance criteria limits are included for information because the action level (2 x waste profile) for some constituents may approach the ERDF waste acceptance criteria limits.
[c] In addition to individual radioactive constituents concentrations, the "sum of fractions" method, as described in the ERDF waste acceptance criteria, shall also be addressed. Each radioactive COC in the waste must be divided by the appropriate limit from the ERDF waste acceptance criteria column, with the sum being less than or equal to 1.0, at a 95% level of confidence. Where there are two or more radioactive constituents present in a waste, the "sum of fractions" method (10 CFR 61.55) shall be used.
[d] ERDF waste acceptance criteria (BHI 1998a) states NL = no limit required except as required by 10 CFR 61.
[e] N/A = No field instrument available to measure concentration.
HPGe = high-purity germanium
XRF = x-ray fluorescence.

4.1 FREQUENCY/INTERVAL OF MEASUREMENTS

Refer to *Section III-2, Sampling Locations and Frequencies*, in the SAP for a general description of sample frequencies and sampling methods. Table 4-3 summarizes the frequency and method of field measurements for excavation, and Table 4-4 lists the standard operating procedures (SOPs) for field instruments.

Table 4-3. Excavation Field Measurement Frequencies.

Analytical Parameters	Case A: Typical Excavation Guidance[a]	Case B: Excavating Through Overburden, Potentially Clean Material, and When Approaching RAGs	Method
	Routine Sample Frequency[b]		
COCs (gamma)	50% surface coverage (boundary)	50% surface coverage (boundary)	NaI
COCs (gamma)	20% surface coverage (internal)	20% surface coverage (internal)	NaI
COCs (gamma isotopes)	When systematic sampling is required (see Section 4.0 criteria), and as directed by the Resident Engineer	Refer to Section 7.2.1 and 7.2.2 (shallow and deep zone verification sampling)	HPGe
COCs (alpha, beta)	As directed by the Resident Engineer	As directed by the Resident Engineer	Plastic Scintillator
Cr (VI)	As directed by the Resident Engineer	As directed by the Resident Engineer	HACH test kit
PCBs	As directed by the Resident Engineer	As directed by the Resident Engineer	Immuno-assay
Metals	As directed by the Resident Engineer	As directed by the Resident Engineer	XRF

[a] Information taken from *Table III-2a* of the SAP.
[b] The values presented are starting points and may be adjusted up or down depending upon conditions.
GM = Geiger-Mueller
HPGe = high-purity germanium
NaI = sodium iodide
PAM = portable alpha monitor
PCBs = polychlorinated biphenyls
XRF = x-ray fluorescence.

To ensure the indicated percentage coverage, use the following guidance for field measurements that will be used to guide excavation:

- 50% surface coverage for boundary: Field measurements should be relatively uniformly distributed to ensure a 50% coverage over the waste site boundary. Perform gamma field surveys on the grid lines indicated on the drawing, if directed by the Resident Engineer. Measure metals concentrations and collect samples for gross alpha and beta analyses as directed by the Resident Engineer.

- 20% surface coverage of internal portion of waste site: Field measurements should be relatively uniformly distributed to ensure a 20% coverage over the waste site interior.

Perform gamma field surveys on the grid lines indicated on the drawing, if directed by the Resident Engineer. Measure metals concentrations and collect samples for gross alpha and beta analyses as directed by the Resident Engineer.

4.2 PROCEDURES

Table 4-4 identifies the SOPs to be used for operating field instruments. A controlled copy of each of the referenced procedures will be maintained at the field site. In general, the SOPs contained in BHI-EE-05, *Field Screening Procedures*, will be followed for field measurements.

Table 4-4. SOPs for Field Instruments.

Field Instrument	SOP
NaI	BHI-EE-05, Procedure 3.5
HPGE	BHI-EE-05, Procedures 2.7 and 2.17
MRDS (includes NaI)	BHI-EE-05, Procedure 2.4
Plastic Scintillator	BHI-01054, *Technical Basis to Describe the Use of the Eberline E-600* (BHI 1998b)
XRF	BHI-EE-05, Procedure 1.31
Cr (VI)	BHI-EE-05, Procedure 1.17
Immunoassay (PCB)	BHI-EE-05, Procedure 1.9

HPGe = high-purity germanium
MRDS = Man-Carried Radiological Detection System
NaI = sodium iodide
PCB = polychlorinated biphenyl.

4.3 PRE-EXCAVATION FIELD RADIOLOGICAL MEASUREMENTS

Perform pre-excavation field radiological measurements along 50% of the grid lines to generate a two-dimensional baseline map. The Resident Engineer will be responsible for decreasing or increasing the grid for future field measurements based on the pre-excavation data.

4.4 FIELD MEASUREMENTS WHILE EXCAVATING THROUGH OVERBURDEN

The Resident Engineer will decide if adequate overburden exists for salvaging as backfill specifically for the site from which it came. Nominal quantities of backfill may be stored in a general backfill pile for use on an as-needed basis subsequent to clean spoils verification. Only contaminated material will be disposed of at ERDF.

If the overburden is to be excavated, perform field measurements as described in Table 4-3, Case B, through each excavation lift and at the direction of the Resident Engineer. The actual boundaries (between clean spoils and contaminated material) of the overburden can then be determined.

4.5 FIELD MEASUREMENTS WHILE EXCAVATING THROUGH SHALLOW ZONE

After overburden is removed, perform field measurements as described in Table 4-3, Case A, and at the direction of the Resident Engineer while excavating through the shallow zone.

If field measurements indicate the material being surveyed is potentially clean, perform measurements as described for Case B under the direction of the Resident Engineer so a determination can be made if the material should be stockpiled for subsequent clean spoils verification.

Additionally, if the field measurements indicate the excavation is nearly complete (i.e., the RAGs are being approached), perform measurements as described in Case B under the direction of the Resident Engineer until it is determined whether verification sampling can begin.

4.6 FIELD MEASUREMENTS WHILE EXCAVATING THROUGH DEEP ZONE

Perform field measurements as described in Table 4-3, Case A, and at the direction of the Resident Engineer while excavating through the deep zone. Field measurements may be limited due to site logistical constraints.

If field measurements indicate that the material being surveyed is potentially clean, perform measurements as described for Case B under the direction of the Resident Engineer so a determination can be made if the material should be stockpiled for subsequent clean spoils verification.

Additionally, if the field measurements indicate that the excavation is nearly complete (i.e., the RAGs are being approached), perform measurements as described in Case B under the direction of the Resident Engineer until it is determined if verification sampling can begin.

5.0 SAMPLE DESIGN

The sample design is based on a minimum detectable difference approach (statistical approach) presented in the U.S. Environmental Protection Agency (EPA) guidance document, *Methods for Evaluating the Attainment of Cleanup Standards, Volume 1: Soils and Solid Media* (EPA 1989). This IG provides specific requirements as they pertain to sample collection. The basis for the sample design is presented in *Appendix A* of the SAP. In short, the SAP specifies that site verification will result in no more then 5% of decision units being declared clean when they are actually dirty (i.e., false-positive, or Type I error), and no more than 20% of decision units will be declared dirty when they are actually clean (i.e., false-negative, or Type II error). As a result, a statistical approach to sample design is required. Composite sample data for the computation of statistical values to represent the upper limit of COCs at the site is used to ensure that site verification conforms to the error tolerance specified.

The sample design divides the site into decision units (i.e., overburden, shallow, and deep zones). One decision unit is the overburden material removed from the excavation during remedial action. The objective for sampling and analyses of overburden and layback is to verify that the suspected clean soil piles do not contain COCs above remediation levels. Another decision unit is the exposed dig face and excavation floor between the original surface elevation and 4.6 m (15 ft) below original ground surface (i.e., shallow zone). If the depth of the excavation is greater than 4.6 m (15 ft) below the original surface elevation, this forms another decision unit (i.e., deep zone).

These decision units are broken into smaller subunits based on surface area. The basis for the number of area-based subunits is summarized in Table 5-1. The area-based subunits were developed using *Table III-4, Size of Decision Units Relative to Size of Waste Sites*, of the SAP. The numbers presented in Table 5-1 are intended to mitigate any rounding problems that may be occur if strictly following *Table III-4* of the SAP. For small sites, a decision unit will encompass only a single subunit.

Table 5-1. Number of Decision Subunits Based on Area.

Area of Primary Decision Unit (ft^2)	Number of Subunits
Small Site	
≤15,000	1
Medium Site	
>15,000 to ≤25,000	2
>25,000 to ≤35,000	3
>35,000 to ≤45,000	4
Large Site	
>45,000 to ≤100,000	2
>100,000 to ≤140,000	3
>140,000 to ≤180,000	4
>180,000 to ≤220,000	5
>220,000	ROUND[a] (Area/40,000)

[a] ROUND is an integer rounding function.

Typically, each subunit is divided into four (shallow zone) or three (deep zone) sample areas, which are in turn divided into 16-node sample grids.

For each site, it will be possible to plan the expected number of decision units and subunits based on the footprint area of the engineered structures and existing data. Sampling and analysis protocols will be identical for any subunits within the decision units categories (i.e., overburden, shallow zone, and deep zone). If contamination is found beyond the engineered structure and excavation of this contamination causes the surface area to expand, then additional decision units may be needed to provide required coverage of the expansion area.

In the overburden and shallow zone, each subunit will initially be divided into four equal size sample areas. In the deep zone, each subunit will be initially divided into three equal size sample areas. Each sample area will be represented by a single verification sample that is a composite sample, with composite aliquots collected from four nodes determined by using the lookup table (Table A-1). Each sample area will be divided into a sample grid consisting of 16 sequentially numbered equal size sample nodes. The six variance samples (overburden and shallow zone only) will come from six randomly determined nodes.

6.0 VARIANCE SAMPLING

The Resident Engineer will decide when the field screening and sodium iodide (NaI) detector data indicate that the RAGs have been met. If it appears that the RAGS have been met by field analytical techniques, variance samples will be collected for overburden and shallow zone assessment. Variance samples will be sent to the RCF for COC analysis, typically by gamma energy analysis (GEA). The sampling frequencies, locations, and procedures for overburden and shallow variance sampling are described below.

Variance sample analytical results will be used to estimate the site dose (based on comparison to lookup values published in the RDR/RAWP [DOE-RL 1998b]) and to calculate the required number of samples for site verification. Specific guidelines for performing these computations are provided in Appendix C of this IG. Six discrete variance samples are collected from random nodes within each sample grid (six variance samples per sample area). The variance samples are used to indicate contaminant variability within a decision unit, thus, all variance samples are used for the computation of variance within the entire decision unit. For example, if six samples are collected from eight sample areas within two subunits that make up the entire decision unit, then all 48 samples (6 x 4 x 2 = 48) will be used for variance computations.

The default number of verification samples is four for overburden and shallow zone decision units. If the number of samples calculated by the COC variability computations is significantly greater than the default number planned for verification sampling, the Resident Engineer will perform a rough cost comparison. This cost comparison will trade-off the cost of collecting additional samples (estimated at $2,100 per sample) versus the cost of additional removal (estimated at $110 per cubic yard). If the cost of sampling is greater than the cost of additional remediation, consider continuing to remove contamination to reduce either the mean or the standard deviation (which will reduce the number of samples needed to show attainment of cleanup standards). Alternately, if variability computations require additional samples (more than the default number of verification samples), the subunits are divided up to contain the appropriate number of samples (per *Appendix A* of the SAP).

Variance sampling is typically integrated with verification sampling due to logistical constraints and limited access to sample media. To minimize procedure repetition and simplify the sample collection process, detailed directions for variance sample collection are presented in Sections 7.2.1 through 7.2.2. An example variance computation is provided in Appendix C.

7.0 VERIFICATION SAMPLING

If the variance sample data indicate that cleanup standards have been achieved, verification samples will be collected. Refer to *Section I.4, Sampling and Analytical Strategies*, of the SAP for detailed discussion on the process flow.

Verification samples will be sent to the SFL for COC analysis. The sampling frequencies, locations, and procedures for overburden, shallow, and deep zone verification sampling are described below.

Verification sampling is based on samples collected within decision units for each site. The four discrete samples are composited to create a single representative verification sample from each sample area within each subunit. The required number verification samples is determined based on the outcome of the variance sampling computations. As a minimum, four samples per sample area are composited for overburden and shallow zone verification, and three samples per sample area are composited for deep zone verification. This minimum number of samples is commonly known as the "default" number of samples, respective of overburden, shallow, and deep zone sampling.

Refer to *Section II 3.1.2, Overburden/Layback, Section II 3.1.3.1, Shallow-Zone Verification*, and *Section II. 3.1.3.2, Deep-Zone Verification*, of the SAP for detailed discussion on the development of shallow zone verification sample strategy. Since overburden soil is used for excavation backfilling, it is subject to the same clean site verification as shallow zone soil.

7.1 FREQUENCY/INTERVAL OF MEASUREMENTS

Section III-2 of the SAP summarizes the sample locations, frequencies, and sampling methods to be followed for shallow zone verification. The subsections below describe how to implement the sampling frequencies and sampling methods described in the SAP:

- *Table III-2c, Sampling Frequencies and Analytical Methods for Site Verification*
- *Table II-3, Summary of the Default Statistical Design for the Overburden/Layback Decision Units*
- *Table II-4, Summary of the Default Statistical Design for the Shallow-Zone Verification Decision Units*
- *Table II-5, Summary of the Default Statistical Design for the Deep-Zone Verification Decision Units*.

Table 7-2 (derived from SAP *Tables III-2c* and *III-3*) provides the quality control sampling requirements for verification sampling. Field split samples should be collected from the same sample as field duplicates. This also applies if regulatory agencies collect split samples for their own analysis.

Table 7-2. Field Quality Control Requirements for Verification Sampling.

QC Sample Type	Frequency	Laboratory
Equipment rinsates (blanks)	1 sample per waste site[a]	SFL
Field duplicates	5% of all samples or a minimum of 1 sample per decision unit	SFL
Field splits	5% of all samples or a minimum of 1 sample per decision unit	Split laboratory
Blind samples	Determined by Resident Engineer	SFL

[a] Work sites as described in Section 1-1 of the SAP.

7.2 PROCEDURE

Three procedures are presented: (1) contingency A, (2) contingency B, and (3) deep zone sites. Contingencies A and B are presented for overburden and shallow zone sites. Contingency A is to be used if the excavation surface is accessible after excavation is complete, and contingency B is to be used if the excavation surface is not accessible after excavation is complete. For deep zone sites, the excavation surface may not be accessible after excavation is complete; sample collection occurs during excavation in a fashion similar to contingency B for overburden and shallow zone sites.

7.2.1 Contingency A – Excavation is Accessible; Overburden and Shallow Zone

The excavation surface is accessible after excavation is complete. Follow the steps below.

Planning:

Step 1: The Resident Engineer will determine the number of decision subunits based on Table 5-1 and the surface area of the stockpiles and the site.

Step 2: The Resident Engineer will divide the overburden, shallow, and deep zones into equal area subunits based on the number determined in Step 1 (refer to Table 5-1 for an example).

Step 3: The Resident Engineer will divide each subunit into the default number of equal size sampling areas. Where practical, the Resident Engineer will use the random number table, provided in Appendix A, to select six sampling locations for each sampling area from a 16-node, equally spaced two-dimensional grid. For example, the subunit area is 930 m^2 (10,000 ft^2), and the dimensions are 30.5 m by 30.5 m (100 by 100 ft). A 16-node grid would have a 7.6-m (25-ft) spacing in each direction to cover this area. The spacing for other sized sampling areas is derived from the area of the subunit divided by 16. For example, a 74.4 m^2 (800 ft^2) area will have sixteen 4.7 m^2 (50 ft^2) sampling locations. The staking of the grid will be directed by the Resident Engineer.

For irregularly shaped overburden piles and sites, sample areas and nodes will be represented by polygonal shapes best suited for equal size subdivisions.

Variance Sampling:

Step 4: Collect a discrete sample at each of the six locations in each of the sampling areas. Analyze the samples at the RCF and provide results to the Resident Engineer.

Step 5: The Resident Engineer will estimate the dose based on lookup values in the RDR/RAWP (DOE-RL 1998b) and will compare nonradionuclide results (if available) to the lookup values (refer to Appendix C). If the data indicate that cleanup levels have been achieved, the Resident Engineer will proceed to Step 6. If the data indicate that cleanup levels have not been achieved, the Resident Engineer will notify project management to determine the appropriate course of action.

Verification Sampling:

Step 6: The Resident Engineer will calculate the required number of composite samples (which equates to the number of sampling areas) to collect in accordance with the SAP (refer to *Appendix C*).

If the required number of verification samples is greater than the default number of composite samples, the Resident Engineer may authorize the collection of the additional samples and may recalculate the required number of verification samples, subsequent to remediation of site hot spots.

If the required number of verification samples is greater than the default number, the Resident Engineer will divide each of the subunits into the required number of sample areas (same as number of required verification samples calculated) or follow the procedure in *Appendix A* of the SAP to perform a cost comparison. This will determine if it is more cost effective to divide each of the subunits into the new higher number of appropriate sample, or continue excavation. Where practical, the Resident Engineer will use a random number table to select additional sampling locations.

Step 7: If the default number of samples are to be collected, the same sampling areas established in Step 3 will be used. Where practical, the Resident Engineer will use a random number table and select four of the six sampling locations selected in Step 3. (NOTE: Using four of the six variance sampling locations, rather than randomly selecting four separate locations, may be useful for correlation data.)

Step 8: From each of the selected four sampling nodes in each sampling area, collect a sample to form a four-sample composite (verification sample).

Result: The default number (or the number determined in Step 6) of verification samples for each subunit are available for site verification. Attainment of closeout will be based on statistics calculated for these verification samples in each subunit.

7.2.2 Contingency B – Excavation is Not Accessible; Overburden and Shallow Zone

The excavation surface is not accessible after excavation is complete. Perform Steps 1 through 3 before excavation begins.

Planning:

Step 1: The Resident Engineer will plan the expected area of the overburden stockpile, shallow, and deep zone before excavation begins. The Resident Engineer will determine the number of subunits based on Table 1 and expected surface area of the stockpiles and site.

Step 2: The Resident Engineer will divide the expected overburden, shallow, and deep zone into equal-area subunits based on the number determined in Step 1 (refer to Table 5-1 for an example).

Step 3: The Resident Engineer will divide each subunit into the default number of equal size sampling areas. Before excavation begins, the Resident Engineer will use the random number table, provided in Appendix A, to select six sampling locations for each sampling area from a 16-node, equally spaced two-dimensional grid. For example, the subunit area is 930 m^2 (10,000 ft^2), and the dimensions are 30.5 m by 30.5 m (100 by 100 ft). A 16-node grid would have a 7.6-m (25-ft) spacing in each direction to cover this area. The spacing for other sized sampling areas is derived from the area of the subunit divided by 16. For example, a 74.4 m^2 (800 ft^2) area will have sixteen 4.7 m^2 (50 ft^2) sampling locations.

Although the sampling grid is two-dimensional, the depth of planned sample locations must be determined prior to excavation. The staking of the grid will be directed by the Resident Engineer. For irregularly shaped overburden piles and sites, sample areas and nodes will be represented by polygonal shapes best suited for equal-area subdivisions.

Variance and Verification Sampling:

Step 4: Collect a discrete sample (for later compositing into verification samples) and a variance sample at each of the six planned sampling locations in each of the four sampling areas during excavation.

Step 5: The Resident Engineer will estimate the dose based on lookup values in the RDR/RAWP (DOE-RL 1998b) and will compare non-radionuclide results (if available) to the lookup values (refer to Appendix C). If the data indicate that cleanup levels have been achieved, the Resident Engineer will proceed to Step 6. If the data indicate that cleanup levels have not been achieved, the Resident Engineer will notify project management to determine the appropriate course of action.

Step 6: After the Resident Engineer determines that verification sample analysis is required, the Resident Engineer will calculate the required number of composite samples (which equates to the number of sampling areas) to collect in accordance with the SAP (refer to *Appendix C*). The Resident Engineer will use a random number table and select required number of sampling locations. (NOTE: Using some of the six variance sample locations, rather than randomly selecting separate locations, may be useful for correlation data.)

Step 7: If it is determined in Step 6 that more than the default number of samples are required, if practical, the Resident Engineer will divide each of the subunits into the required number of sample areas and use the discrete samples (from Step 4) to composite into verification samples. The Resident Engineer will use a random number table and select discrete samples (obtained in Step 4) for compositing into required number of verification samples.

If not enough discrete samples were taken to support the creation of the required number of verification samples, the Resident Engineer may authorize the collection of additional samples or follow the procedure in *Appendix A* of the SAP to perform a cost comparison to determine the appropriate number of composite samples to collect.

Step 8: Composite the four discrete samples from each sampling area to create a verification sample representing each sample area.

Result: Since the discrete samples have already been retrieved (during excavation), verification samples for each sample area are available for site verification. Attainment of closeout will be based on statistics calculated for the verification samples in each subunit.

7.2.3 Deep Zone

For deep zone sites, follow the steps below.

Planning:

Step 1: The Resident Engineer will determine the number of decision subunits based on Table 5-1 and the surface area of the deep zone.

Step 2: The Resident Engineer will divide the deep zone into equal-area subunits based on the number determined in Step 1 (refer to Table 5-1 for example).

Step 3: The Resident Engineer will divide each subunit into three equal size sampling areas. Where practical, the Resident Engineer will use the random number table, provided in Appendix A, to select four sampling locations for each sampling area from a 16-node, equally spaced, two-dimensional grid. For example, the subunit area is 930 m^2 (10,000 ft^2), and the dimensions are 30.5 m by 30.5 m (100 by 100 ft). A 16-node grid would have a 7.6-m (25-ft) spacing in each direction to cover this area. The spacing for other sized sampling areas is derived from the area of the subunit divided by 16. For example, a 74.4 m^2 (800 ft^2) area will have sixteen 4.7 m^2 (50 ft^2) sampling locations. The staking of the grid will be directed by the Resident Engineer.

For irregularly shaped sites, sample areas and nodes will be represented by polygonal shapes best suited for equal-area subdivisions.

Verification Sampling:

Step 4: If the excavation surface is not accessible after excavation is complete, collect a discrete sample (for later compositing into verification samples) from each of the four planned sampling nodes in each of the three sampling areas during excavation. If the excavation surface is accessible after excavation is complete, collect and composite verification samples from each of the four planned sampling nodes in each of the three sampling areas.

Step 5: Composite the four discrete samples to create a verification sample for each sampling area (three verification samples total per subunit).

Result: Three composite samples are obtained for each subunit. Attainment of closeout will be based on the statistics calculated for these verification samples in each decision subunit.

7.3 STANDARD SAMPLING PROCEDURES

Follow the SOPs found in BHI-EE-01, *Environmental Investigations Procedures*, for verification sampling, sample compositing, sample packaging and shipping, and chain of custody. A controlled copy of the referenced procedures will be maintained at the field site.

8.0 BACKFILL

There are two types of backfill material: overburden and imported backfill. Overburden is sampled and verified as acceptable for use as backfill material as described in Section 7.2.1. Acceptance or rejection of soils for imported backfill material will be based on existing knowledge of the prospective borrow areas. The imported backfill will be radiologically surveyed as a check for suitability for use as clean fill, as described in the sections below.

8.1 ANALYTICAL PARAMETERS (COCs)

Refer to *Section II 3.1.4, Imported Backfill*, of the SAP for a discussion on the backfill sampling logic. Radiation surveys with handheld instruments for gross gamma/beta activity will be used to verify that backfill is uncontaminated.

8.2 FREQUENCY/INTERVAL OF MEASUREMENTS

Perform radiological surveys of backfill as directed by the Resident Engineer.

8.3 STANDARD SAMPLING PROCEDURES

Refer to Table 4.4 of this IG for field instrument SOPs.

9.0 DATA MANAGEMENT

Refer to *Section II.3.10* of the SAP for a detailed discussion of data management requirements. In addition, *Figure II-1, Sample and Data Management Process Flow*, illustrates the data flow requirements.

More specifically, follow BHI-EE-01, Procedure 1.5, "Field Logbooks," and provide daily reports of analytical results to the Resident Engineer for review and input into the project-specific database.

The Hanford Environmental Information System (HEIS) database numbers will be assigned to all samples analyzed by QTL, SFL, x-ray fluorescence (XRF), and by high-purity germanium detectors (HPGe).

Project calculations will be completed and maintained per the *Design Engineering Procedures Manual* (BHI-DE-01), Procedure EDPI-4.37-01, "Project Calculations."

10.0 WASTE MANAGEMENT

All waste generated through field sampling and screening will be handled in accordance with the site-specific waste management instruction for the remediation of 100-BC-1, 100-DR-1, and 100-HR-1 sites.

11.0 REFERENCES

10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Material," *Code of Federal Regulations*, as amended.

BHI, 1998a, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, BHI-00139, Rev. 3, Bechtel Hanford, Inc., Richland, Washington.

BHI, 1998b, *Technical Basis to Describe the Use of the Eberline E-600*, BHI-01054, Rev. 2, Bechtel Hanford, Inc., Richland, Washington.

BHI-DE-01, *Design Engineering Procedures Manual*, Bechtel Hanford, Inc., Richland, Washington.

BHI-EE-01, *Environmental Investigations Procedures*, Bechtel Hanford, Inc., Richland, Washington.

BHI-EE-05, *Field Screening Procedures*, Bechtel Hanford, Inc., Richland, Washington.

BHI-QA-03, *ERC Quality Assurance Program Plans*, Bechtel Hanford, Inc., Richland, Washington.

BHI-SH-04, *Radiological Control Work Instructions*, Bechtel Hanford, Inc., Richland, Washington.

DOE-RL, 1998a, *100 Area Remedial Action Sampling and Analysis Plan*, DOE/RL-96-22, Rev. 1, U.S. Department of Energy, Richland Operations Office., Richland, Washington.

DOE-RL, 1998b, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, DOE/RL-96-17, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

EPA, 1989, *Methods for Evaluating the Attainment of Cleanup Standards, Volume 1: Soils and Solid Media*, EPA 230/02-89-042, U.S. Environmental Protection Agency, Washington D.C.

WMI-GRP4-001, Rev. 0, *Site-Specific Waste Management Instruction*, Bechtel Hanford, Inc., Richland, Washington.

APPENDIX A

SAMPLE GRID LOOKUP TABLE

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Table A-1. Sample Grid Lookup Table.

Default Plan	Sampling Area 1	Sampling Area 2	Sampling Area 3	Sampling Area 4	Sampling Area 5	Sampling Area 6	Sampling Area 7	Sampling Area 8	Sampling Area 9	Sampling Area 10
HPGe/closeout	3	6	1	4	5	1	3	3	4	16
HPGe/closeout	4	7	11	3	15	15	5	13	10	10
HPGe/closeout	16	3	2	7	7	10	11	4	3	14
HPGe/closeout	10	15	4	12	1	13	4	8	16	4
HPGe	2	14	5	9	13	12	8	2	14	8
HPGe	13	10	9	13	2	16	1	12	5	3
Not sampling	6	1	10	8	14	4	16	5	8	6
Not sampling	1	9	13	1	10	5	12	1	1	15
Not sampling	9	12	7	5	6	2	6	7	15	9
Not sampling	15	16	15	14	16	6	2	15	11	1
Not sampling	8	13	8	10	12	11	13	14	2	12
Not sampling	5	2	3	11	4	3	9	10	7	11
Not sampling	7	11	14	15	11	14	14	6	13	2
Not sampling	11	4	6	2	9	7	7	11	9	7
Not sampling	12	8	16	16	3	8	15	9	6	13
Not sampling	14	5	12	6	8	9	10	16	12	5

NOTE: Grid nodes for each sampling area in each waste site should be numbered consistently (e.g., begin numbering the nodes in the northwestern-most node, then number consecutively left to right, as shown in Table 5-1 of this IG).

APPENDIX B

ADDITIONAL INFORMATION AND CONTAMINANTS OF CONCERN FOR SITES NOT DISCUSSED IN THE SAMPLING ANALYSIS PLAN

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1.0 STRATEGY FOR VERIFICATION OF ANALOGOUS SITE DATA (COC DETERMINATION)

Due to a lack of waste inventory and process knowledge for multiple Hanford Site waste sites, the following strategy should be consulted to help determine contaminants of potential concern (COPCs) and to refine contaminants of concern (COCs) for such sites, barring that pre-established COPCs and COCs are not available as the result of site data quality objectives (DQOs).

The COPCs and COCs shall be chosen by the project and appropriate technical experts after consideration of the following:

- Available waste designation and characterization data (both fixed laboratory and field screening results)
- Process knowledge data and inventory including effluent composition and construction material used in engineered structures
- Analogous site data
- Detectable contaminants that are above background and/or within one order of magnitude (one-tenth) of the lookup values published in the remedial design report/remedial action work plan (RDR/RAWP) (DOE-RL 1998)
- Detectable radioisotopes that are of sufficient quantity to be dose contributors at the site
- Undocumented, yet reasonable, discharges reported during interviews with operations personnel
- Other contaminants as determined based on other data sources and concurred upon by project staff, technical experts, and regulators.

The COPCs are simply COCs for which insufficient site analytical data is available to confirm their presence at the site. Upon evaluation of site analytical data, COPCs may be retained as COCs to be sampled and monitored during the course of remediation and/or clean site verification. The COPCs may be dropped from further consideration if sufficient data exist to indicate that these COPCs are not present at the site above background at quantities that would exceed one order of magnitude (one-tenth) of the lookup value or constitute a potential threat to human health and the environment.

The sections that follow provide an example of how available data are used to establish site COCs.

2.0 1607-D2 SEPTIC TANK SYSTEM – COC DETERMINATION

The 1607-D2 Septic Tank system is located in the 100-D Area approximately 15.3 m (50 ft.) south of the 116-D-7 Retention Basin. The septic tank and downstream header box supported

100-D Area sanitary and laboratory facilities. It is not known if the septic system received radioactive or hazardous wastes; however, the septic system supported facilities where these materials were routinely used.

During March 1996, investigative sampling of the tank and header box were performed to determine if remediation would be required. The septic tank was observed to be approximately one-half full of liquid sewage. The header box was nearly empty. The toxicity characteristic leachate procedure (TCLP) results were below dangerous waste toxicity characteristic thresholds. However, total metals results indicated levels of lead (Pb), mercury (Hg), and total chromium (Cr) exceeding *Model Toxics Control Act* (MTCA) Method B default values. Three samples from the septic tank yielded results for bis(2-ethylhexyl)phthalate greater than the MTCA B default value for protection of groundwater (625 μg/kg). The three results were 5,800, 5,800, and 7,300 μg/kg. The associated laboratory blank contained no detects of bis(2-ethylhexyl)phthalate (the detection limit was 330 μg/kg). Two samples contained concentrations of europium-152 that exceed a dose rate of 15 mrem/yr, the remedial action goal (RAG) for radionuclides. Because of the detections, the contaminants discussed will be added to the COC list for the 1607-D2 Septic Tank (see Table B-1). Reference IOM# 034615, *Group 2 Investigation Results*, dated July 26, 1996.

Table B-1. Contaminants of Concern for Remediating the 1607-D2 and 116-DR-9 Sites.

Site Number	Name	Radiological COC	Chemical COC
1607-D2	Septic Tank	^{152}Eu	Cr (total), Hg, Pb, bis(2-ethylhexyl)phthalate
1607-D2	Abandoned Tile Field	^{152}Eu	Cr^{+6}, Hg, Pb, PCBs bis(2-ethylhexyl)phthalate
116-DR-9	Retention Basin	^{241}Am, ^{60}Co, ^{137}Cs, ^{152}Eu, ^{154}Eu, ^{155}Eu, ^{238}Pu, $^{239/240}$Pu, ^{90}Sr	Cr^{+6}, bis(2-ethylhexyl)phthalate

The 1607-D2 Abandoned Tile Field sub-site is located near the east side of the 116-DR-9 Liquid Effluent Retention Basin facility. Sewage from the 1607-D2 Septic Tank discharged to the tile field from 1944 to 1950. In 1950, the tile field was partially demolished for the construction of the 116-DR-9 Retention Basin and a replacement tile field was constructed north of the retention basins. The name "Abandoned Tile Field" was assigned to the infrastructure remaining and adjacent to the 116-DR-9 Retention Basin. Based on characterization data from the 1607-D2 Septic Tank and the adjacent 107-D1 Sludge Pit, the COPCs for the 1607-D2 Abandoned Tile Field included the following:

- Polychlorinated biphenyls (PCBs) — Discovered in sediments inside the drain field tile

•	Pb	Septic tank sampling found in tile field grab samples; use graphite-furnace atomic absorption (GFAA)
•	Cr VI	Elevated levels of total chromium were measured in the septic tank sludge, and speciation is needed to determine compliance
•	Hg	COC for septic tank sampling and tile field sampling, found in tile field grab samples
•	Gamma energy analysis (GEA)	Europium-152 by GEA is a COC for septic tank sampling; propose analyzing for all gamma emitters
•	*U-235/U-238*	*Speciation is needed due to elevated levels of* total uranium found in septic sludge; use alpha energy analysis
•	Semivolatile organic analysis (SVOA)	Polyaromatic hydrocarbons and phthalates were present at elevated levels in the septic tank.

During February 1998, the 1607-D2 Abandoned Tile Field was remediated and sampled for clean site verification. The analytical data were evaluated to determine if additional constituents beyond the proposed site COCs were detected.

Data from eight analytical samples were evaluated (the eight samples consisted of four main samples, one duplicate sample, one split sample, one equipment blank sample, and one field blank sample). The evaluation of the data resulted in the following conclusions.

- PCBs, mercury, Cr^{+6} cobalt-60, cesium-137, europium-152, and europium-154 were not detected.
- No SVOAs were detected except:
  - 1,3-dimethyl-cyclohexane (one sample, 620JN ug/kg)
  - 2,4,4-trimethyl-2-pentene (two samples, 490 to 590JN ug/kg)
  - Several tentatively identified compounds (TICs) (seven samples, 99BJ to 1000BJ ug/kg)

  (Note that 2,4,4-trimethyl-2-pentene was also detected in the laboratory blank at 490JN ug/kg.)
- Lead was detected (seven samples, 1.1 to 4.8 mg/kg)

- Americium-241 was detected (four samples, 0.117J to 0.0123J pCi/g)
- Uranium-234 was detected (seven samples, 0.315J to 0.667J pCi/g)
- Uranium-235 was detected (one sample, 0.0462J pCi/g)
- Uranium-238 was detected (eight samples, 0.297J to 0.762J pCi/g)
- Plutonium-238 was detected (two samples, 0.0152J to 0.0275J pCi/g)
- Plutonium-239/240 was detected (seven samples, 0.0648 to 0.375 pCi/g)
- "J" indicates that the result is estimated and is below the lower quantification value. "N" indicates that the recovery for the associated data was out of range. "B" indicates the associated analyte was also found in the laboratory quality control (QC) blank.

Based on the evaluation, the following COPCs were not retained as COCs for the site:

- 1,3-dimethyl-cyclohexane and 2,4,4-trimethyl-2-pentene were not listed in the CLARC II (MTCA Method B) tables.
- All TICs are in the very low parts per million (ppm) range and were found in the laboratory QC blank
- Americium-241, uranium-235, plutonium-238, and plutonium-239/240 were below one-tenth of the direct exposure RAG (DOE-RL 1998)
- Uranium-234 and uranium-238 were below Hanford Site background.

Based on the evaluation, the COPCs were refined to COCs for the site: europium-152, Cr^{+6}, lead, mercury, PCBs, and bis(2-ethylhexyl)phthalate.

Although Cr^{+6} was not detected, elevated levels of total chromium were measured in the septic tank sludge. Although PCBs, lead, and mercury were not detected, they were found in previous tile field grab samples. PCBs were also detected in a neighboring site (107-D-1) during its remediation. Although bis(2-ethylhexyl)phthalate was not detected, it was detected in the septic tank at levels as high as 7,300 ug/kg.

3.0 116-DR-9 RETENTION BASIN – COC DETERMINATION

The 116-DR-9 Retention Basin held cooling water effluent from the 105-D/105-DR Reactors for decay and thermal cooling before release to the Columbia River. The basin also received cooling water contaminated with ruptured fuel elements. Sampling analytical results from the 100-DR-1 limited field investigation (LFI) performed in 1991 indicated that bis(2-ethylhexyl)phthalate was detected in two samples at concentrations greater than the MTCA Method B default value for protection of groundwater (625 µg/kg). These two samples were collected from a vadose zone borehole between 9.1 and 11.4 m (30 and 37.5 ft) below ground surface. Research of available data and historical information was performed to determine if the reported values of the bis(2-ethylhexyl)phthalate (4,800 µg/kg and 5,200 µg/kg) were valid. The following summarizes the findings:

- The bis(2-ethylhexyl)phthalate results exceeding MTCA Method B default values were found in two samples from the 199-D8-66 borehole, which was reported in the LFI report for the 100-DR-1 Operable Unit (DOE-RL 1994) as the 116-DR-9C LFI borehole. The sample results are shown below:

  - Sample B018D1: 4,800 µg/kg, sample depth 9.1 to 10.0 m (29.9 to 32.7 ft) below ground surface

  - Sample B018D2: 5,200 µg/kg, sample depth 10.6 to 11.4 m (34.7 to 37.5 ft) below ground surface

- The *Qualitative Risk Assessment for the 100-DR-1 Source Operable Unit* (WHC 1994) (QRA), Appendix G, Data Assessment Based on Laboratory and Field Blanks, was reviewed for bis(2-ethylhexyl)phthalate. It was concluded after this review that the QRA was invalid in determining that the result from sample B018D1 was undetected because it was ≤ 10 times the associated laboratory blank result (sample B018D2 was not included in the QRA data assessment).

  The highest laboratory blank reported in the QRA (490 µg/kg) was not the laboratory blank associated with sample B018D1. The laboratory report containing the results for both B018D1 and B018D2 and the corresponding laboratory blank was obtained from the Environmental Restoration Contractor (ERC) Sample and Data Management group. The associated laboratory blank contained no detects of bis(2-ethylhexyl)phthalate (the detection limit was 330 µg/kg). Therefore, the results of samples B018D1 and B018D2 cannot be written off as laboratory contamination.

- Butylbenzylphthalate and di-n-butylphthalate were also found in multiple samples within two LFI boreholes. The concentrations reported do not exceed MTCA Method B default values. Laboratory blank results corresponding to the samples did not contain phthalates greater than detection (330 µg/kg). Therefore, these samples cannot be written off as laboratory contaminants, and thus, other species of phthalates in addition to bis(2-ethylhexyl)phthalate exist within the 116-DR-9 Retention Basin.

- As discussed in Section B.1, bis(2-ethylhexyl)phthalate was found within the 1607-D2 Septic Tank in concentrations greater than MTCA Method B default values also. Hanford Site drawing H-1-8547 shows a tile field northeast of the 1607-D2 Septic Tank that was approximately 70% within the current 116-DR-9 Retention Basin east boundary and approximately 30% outside the east retention basin boundary. A pipeline is shown running from the septic tank in a northeasterly direction to the southwest side of the tile field. A portion of the tile field was subsequently removed during construction of the retention basin. Ground-penetrating radar (GPR) data recently obtained from the area around the 116-DR-9 Retention Basin indicated remnants of the tile field outside the boundary of the retention basin still exist. Therefore, because of the concentrations of bis(2-ethylhexyl)phthalate found in the septic tank and the fact that there used to be a pipeline connecting the septic tank to the tile field where the 116-DR-9 Retention Basin now exists, a source of bis(2-ethylhexyl)phthalate in the area within and near the 116-DR-9 Retention Basin exists.

After examining the above findings, it has been concluded that bis(2-ethylhexyl)phthalate will be added to the 116-DR-9 COC list because of the following: (1) the detected bis(2-ethylhexyl)phthalate cannot be written off as a laboratory contaminant, (2) a source of bis(2-ethylhexyl)phthalate exists, and (3) the detected bis(2-ethylhexyl)phthalate is greater than MTCA Method B cleanup levels (see Table B-1).

4.0 REFERENCES

DOE-RL, 1994, *Limited Field Investigation Report for the 100-DR-1 Operable Unit*, DOE/RL-93-29, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1998, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, DOE/RL-96-17, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

WHC, 1994, *The Qualitative Risk Assessment for the 100-DR-1 Source Operable Unit*, WHC-SD-EN-RA-005, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

APPENDIX C

EXAMPLE VARIANCE COMPUTATION

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ERC TEAM

CALCULATION SHEET

Originator	**D. B. Blumenkranz**	Date	**12/16/97**	Calc. No.	**0100B-CA-V0012**	Rev. No.	**0**
Project	**100-BC Remedial Action**	Job No.	**22192**	Checked		Date	
Subject	**Required number of Samples for 116-C-1 Side Wall (units 1-2) & Overburden (units 1-4)**					Sheet No.	**1 of 18**

Problem:
Calculate the number of verification samples needed for 116-C-1 side wall shallow zone as required Field Instruction Guide (100-IG-G0001, Rev. 1).

Given:
1) Sample Results (Worksheet "Data Summary") & Sample Location (Worksheets "Side Wall Samples" and "Overburden Samples").
2) Lookup values from SAP DOE/RL-96-22 Rev. 0
3) SAP (DOE/RL-96-22 Rev. 0) and IG (0100X-IG-G0001 Rev. 1) requirements
4) Sample locations indicated on Calculation 0100B-CA-V0009

Solution:
Calculation methodology is described in Attachment A-1 of the Sampling and Analysis Plan (DOE/RL-96-22 Rev.0). Use data from attached worksheets to calculate the required number of samples.

Sheet No.	*Contents (Worksheets):*	*Topic:*
1	Calc. Summary	Summary of Calculation Brief
2	116-C-1 Side Wall, Unit 1	Required Number of Samples Calculation
3	116-C-1 Side Wall, Unit 2	Required Number of Samples Calculation
4	116-C-1 Overburden, Unit 1	Required Number of Samples Calculation
5	116-C-1 Overburden, Unit 2	Required Number of Samples Calculation
6	116-C-1 Overburden, Unit 3	Required Number of Samples Calculation
7	116-C-1 Overburden, Unit 4	Required Number of Samples Calculation
8	116-C-1 Side Wall, Unit 1, Formulas	Spreadsheet Formulas for Corresponding Calculation
9	116-C-1 Side Wall, Unit 2, Formulas	Spreadsheet Formulas for Corresponding Calculation
10	116-C-1 Overburden, Unit 1, Formulas	Spreadsheet Formulas for Corresponding Calculation
11	116-C-1 Overburden, Unit 2, Formulas	Spreadsheet Formulas for Corresponding Calculation
12	116-C-1 Overburden, Unit 3, Formulas	Spreadsheet Formulas for Corresponding Calculation
13	116-C-1 Overburden, Unit 4, Formulas	Spreadsheet Formulas for Corresponding Calculation
14-16	Data Summary	Sample ID, Location, and Analytical Results
17	Side Wall Samples	Side Wall Samples Identification and Location
18	Overburden Samples	Overburden Samples Identification and Location

Calculations and Data sheets are interlinked within the spreadsheet such that a change in the data will effect the calculation. A "=IF" statement (refer to formula sheets, column J) is used to verify that the sample ID (HEIS number) is correctly assigned to the appropriate analytical result.

	A	B	C	D	E	F	G	H	I	J
1								CALCULATION SHEET		
2		Originator	DB Blumenkranz			Date		12/8/97		Calc. No. 0100B-CA-V0012 Rev. No. 0
3		*Project:*	*100-BC-1*			*Job No.*		*22192*		*Checked* Date
4		Subject:	116-C-1, Side Wall Shallow Zone, Decision Unit 1, Required Number of Verification Samples							Sheet No. 2 of 18
5										
6		Problem:	Calculate the number of verification samples needed for 116-C-1 side wall shallow zone as required Field Instruction Guide (100-IG-G0001, Rev. 1).							
7	1		*Calculations are described in Attachment A-1 of the Sampling and Analysis Plan (DOE/RL-96-22 Rev.0)*							
8	2	Given:	- Sample Results (Worksheet "Data Summary") & Sample Location (Worksheet "Side Wall Samples")							
9	3		- Lookup values from SAP DOE/RL-96-22 Rev. 0							
10	4		- SAP (DOE/RL-96-22 Rev. 0) and IG (0100X-IG-G0001 Rev. 1) requirements							
11	5	**Sampling Area: Side Wall**								
12	6	Samples values from Gamma Energy Analysis (GEA) in pCi/g.								
13	7									
14	8					Constituent				
15	9	Sample #	Location	Co60		Cs137		Eu152		
16	10	**Look-up Value==>**		**1.40E+00**		**6.20E+00**		**3.30E+00**		
17	11	B0HJK5	A1-02	6.51E-02	U	5.12E-02	U	2.80E-01	U	
18	12	B0HJK4	A1-03	7.42E-02		9.30E+00		2.58E-01		
19	13	B0HJP2	A1-04	1.19E-02	U	2.00E-02	U	8.29E-02	U	
20	14	B0HJP3	A1-10	1.98E-02		1.77E-02	U	8.42E-02	U	
21	15	*B0HJP4*	*A1-13*	*7.90E-02*		*4.58E-01*		*2.57E-01*	*U*	
22	16	B0HJP5	A1-16	2.07E-02	U	1.15E-01		7.03E-02	U	
23	17	B0HJK3	A2-03	2.31E-02	U	1.09E-01		2.87E-01	U	
24	18	B0HJK2	A2-06	7.05E-02	U	5.99E-02	U	2.95E-01	U	
25	19	B0HJK1	A2-07	8.76E-02	U	6.47E-02	U	3.12E-01	U	
26	20	B0HJK0	A2-10	7.35E-02	U	5.90E-02	U	3.41E-01	U	
27	21	B0HJJ9	A2-14	6.51E-02	U	5.45E-02	U	2.40E-01	U	
28	22	B0HJJ8	A2-15	7.25E-02	U	5.57E-02	U	2.53E-01	U	
29	23	B0HJN8	A3-01	6.70E-02	U	5.57E-02	U	2.60E-01	U	
30	24	B0HJN9	A3-02	1.89E-02		1.42E-02	U	6.00E-02	U	
31	25	B0HJP0	A3-04	5.75E-02	U	5.83E-02	U	1.56E-01	U	
32	26	B0HJP1	A3-05	1.92E-02	U	6.91E-02		1.57E-01		
33	27	B0HJN6	A3-09	6.29E-02	U	5.89E-02	U	3.03E-01	U	
34	28	B0HJN7	A3-11	1.09E-02	U	1.29E-02	U	5.85E-02	U	
35	29	B0HJN3	A4-03	1.15E-02	U	1.52E-02	U	1.89E-01	U	
36	30	B0HJN4	A4-04	2.42E-02	U	3.57E-01		6.28E-01		
37	31	B0HJN5	A4-07	2.39E-02	U	1.22E-01		2.73E-01		
38	32	B0HJN2	A4-09	7.92E-02	U	5.07E-02	U	2.58E-01	U	
39	33	B0HJN0	A4-12	1.65E-02	U	2.56E-02	U	1.32E-01	U	
40	34	B0HJN1	A4-13	6.93E-02	U	5.43E-02	U	2.79E-01	U	
41	35	Mean============>		4.67E-02		4.70E-01		2.28E-01		
42	36	Standard Deviation==>		2.78E-02		1.88E+00		1.24E-01		
43	37	τ ============>		4.87E+01		3.04E+00		2.46E+01		
44	38	Number of Samples>		2.60E-03		6.68E-01		1.01E-02		

Excel Spreadsheet Formulas (used in above example)

Value	Formula	Description
Mean==========>	=AVERAGE(D17:D40)	Average (Ave.) COC concentration
Standard Deviation=>	=STDEV(D17:D40)	Standard Deviation (Std. Dev.) of COC concentration
τ ==============>	=(D41-D16)/D42	τ =(Ave.-Lookup value)/(Std. Dev.)
Number of Samples>	=(0.842+1.645)^2/D43^2	(Error Quantiles)^2/τ

Refer to SAP, *Attachment A-1*.

APPENDIX D

RADIOLOGICAL FIELD SCREENING GUIDANCE

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1.0 PURPOSE

The purpose of this appendix is to provide guidance regarding the frequency of measurement and action levels for the radiological control technician (RCT) performing surveys in support of 100 Area remedial action sites. The survey performed is primarily to guide excavation of soils and material.

2.0 SCOPE

This guidance is limited to 100 Area operable units (OUs) currently undergoing remediation. This guidance is for aiding the 100 Area OUs in the excavation of soils and material. It is not for release of the site. The guidance provides the action levels and frequency of measurements when using hand-held instruments used in determining the level of radioactivity in soil and soil-like material; it is not for material that has surface contamination. Items with surfaces (not contaminated in depth or volume) will be surveyed and released based on the guidance in the site-specific survey technical assessment.

3.0 BACKGROUND

The cleanup level for radioactivity is based on a rural residential scenario where the land occupants receive 15 mrem/yr of exposure. The data gathered is compiled to achieve a 95% upper confidence limit from guidance provided by the U.S. Environmental Protection Agency. The clean up of the waste sites within the OU boundaries will be verified during the closeout process.

4.0 REQUIREMENTS

The RCTs will operate the instruments in accordance with the following procedures:

- BHI-EE-05, *Field Screening Procedures*, Procedure 3.5, "Performing Radiological Characterization Surveys in Support of the 100-Area Remedial Action Sites"
- BHI-EE-05, Procedure 2.11, "Portable Environmental Survey Instrument Operability Checks."
- BHI-EE-05, Procedure 2.12, "Eberline E-600 Usage for Environmental Surveys."

The RCTs will be trained on the use of the instrument and the rate meter to which it is attached.

5.0 PROCEDURE

As directed by the Analytic Lead, radiologic characterization surveys will be performed. Not all waste sites require characterization surveys. Generally, characterization surveys are needed near the edges of waste sites and at the bottom of waste sites. When Man-Carried Radiological

Detection System (MRDS) and Laser-Assisted Ranging and Data System (LRDS) surveys are not feasible, surveys using hand-held instruments may be useful. The Analytic Lead will notify the RadCon Supervisor when surveys using hand-held instruments are needed.

When surveys are needed during excavation, one survey is required per truck load. To maintain maximum efficiency, this survey may be performed after one truck is filled and is departing the dig face and a second tuck is approaching the waste site. When readings exceed 1.75 times background, the RCT will notify the Analytic Lead. The Analytic Lead may request additional surveys.

When waste site readings are greater than two times the background level, the RCT will notify the RCT Supervisor and the Analytic Lead. Soil from waste sites reading greater than two times background will be sent to the Environmental Restoration Disposal Facility. Soil from waste sites reading less than two times background may be sent to the overburden pile for future testing.

6.0 REVISIONS

Changes to this implementation guide are made based on requirements of BHI-DE-01, *Design Engineering Procedures Manual.* Expeditious changes to this appendix may be made via a Field Change Notice (FCN) or Design Change Notice (DCN). Requirements for these change notices are described in BHI-DE-01, EDPI-4.62-01, "Field Change Request (FCR) and Field Change Notice (FCN)."

7.0 *REFERENCES/BIBLIOGRAPHY*

BHI, 1996, *Instrumental Basis Utilizing a Sodium Iodide Detection for Radioactive Soil Evaluations for Site Remediation,* BHI-00885, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI-DE-01, *Design Engineering Procedures Manual,* Bechtel Hanford, Inc., Richland, Washington.

BHI-EE-05, *Field Screening Procedures,* Bechtel Hanford, Inc., Richland, Washington.

DOE-RL, 1998, *Remedial Design Report/Remedial Action Work Plan for the 100 Area,* DOE/RL-96-17, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.